Agenda

1. Motivation
2. Influential parameters
3. Impact of UV and OBA amount
4. Evaluating optical brightener agents
5. Characterization data and ICC profiles ("FOGRA51/52")
6. Outview

Development of methods to compensate the difference between proofing and production stock
AiF-Nr.: 16607 N
Intermediate findings

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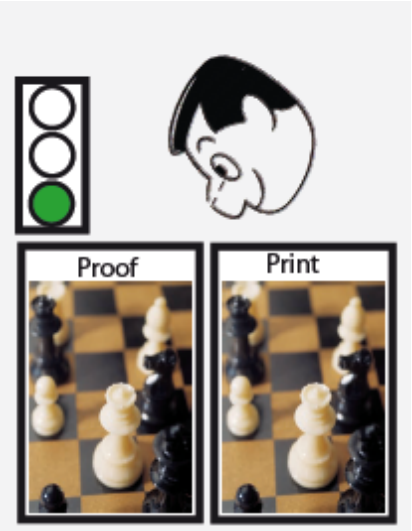
1. Motivation

- Important for the printing industry: Proof to print match

Proof:

- mostly by Inkjet
- Substrates mostly with no/lss OBA ⇒ Lichtechtheit
- Differences with Print:
  - Sbstrate (OBA-amount)
  - Screening
  - Colorants

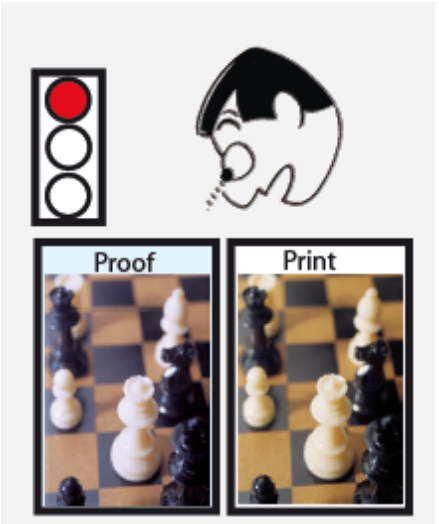
OBA, Optical Brightening Agent



Production (Print):

- Pressrun (Offset, Gravure etc)

- By assessing/comparing substrates with different amounts of OBA under ISO 3664:2009 norm light (D50 UV amount) there are colour differences since the papers react differently

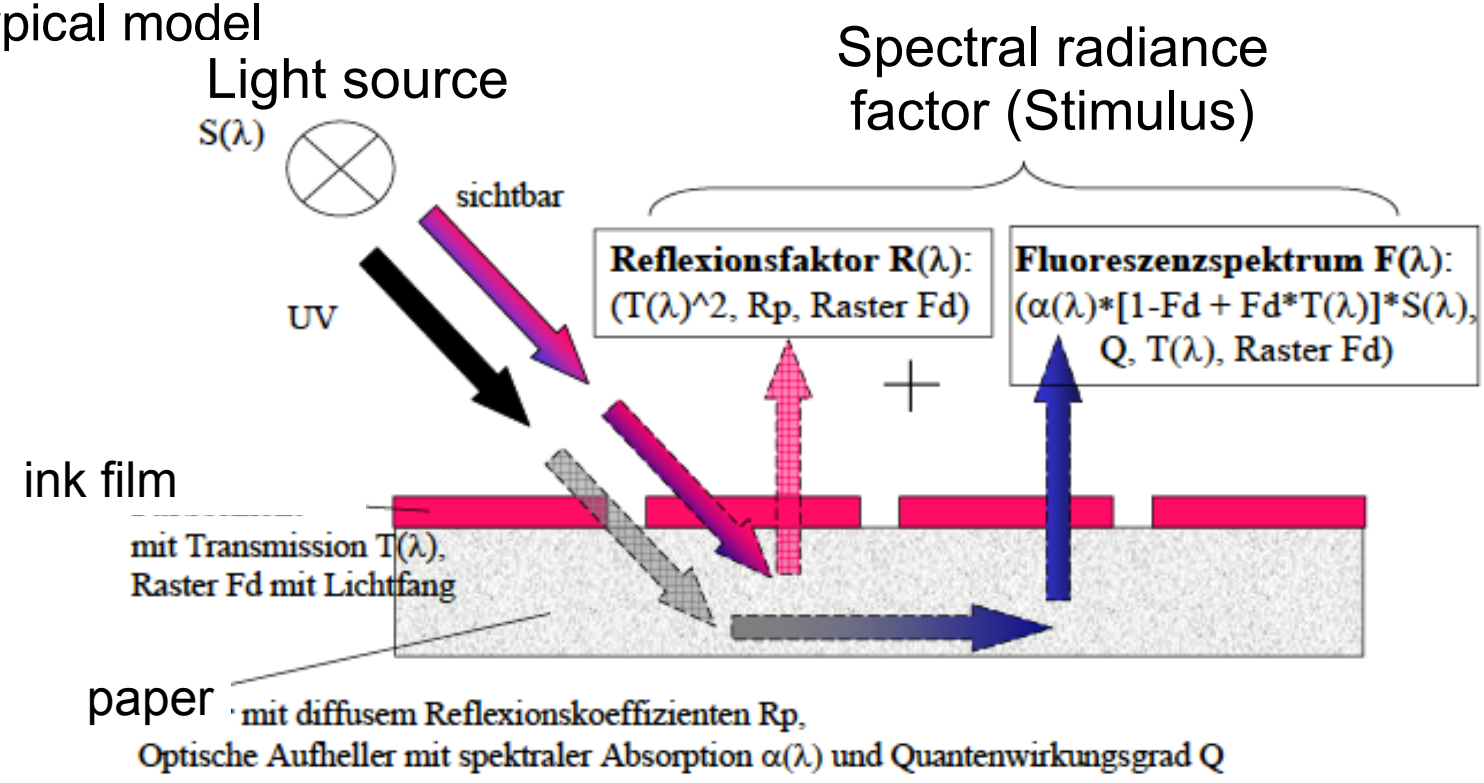


2. Modelling the physical stimulus

- Reflection factor is basically governed by subtractive colour mixing (absorption) of the screen ink layers against the basic substrate

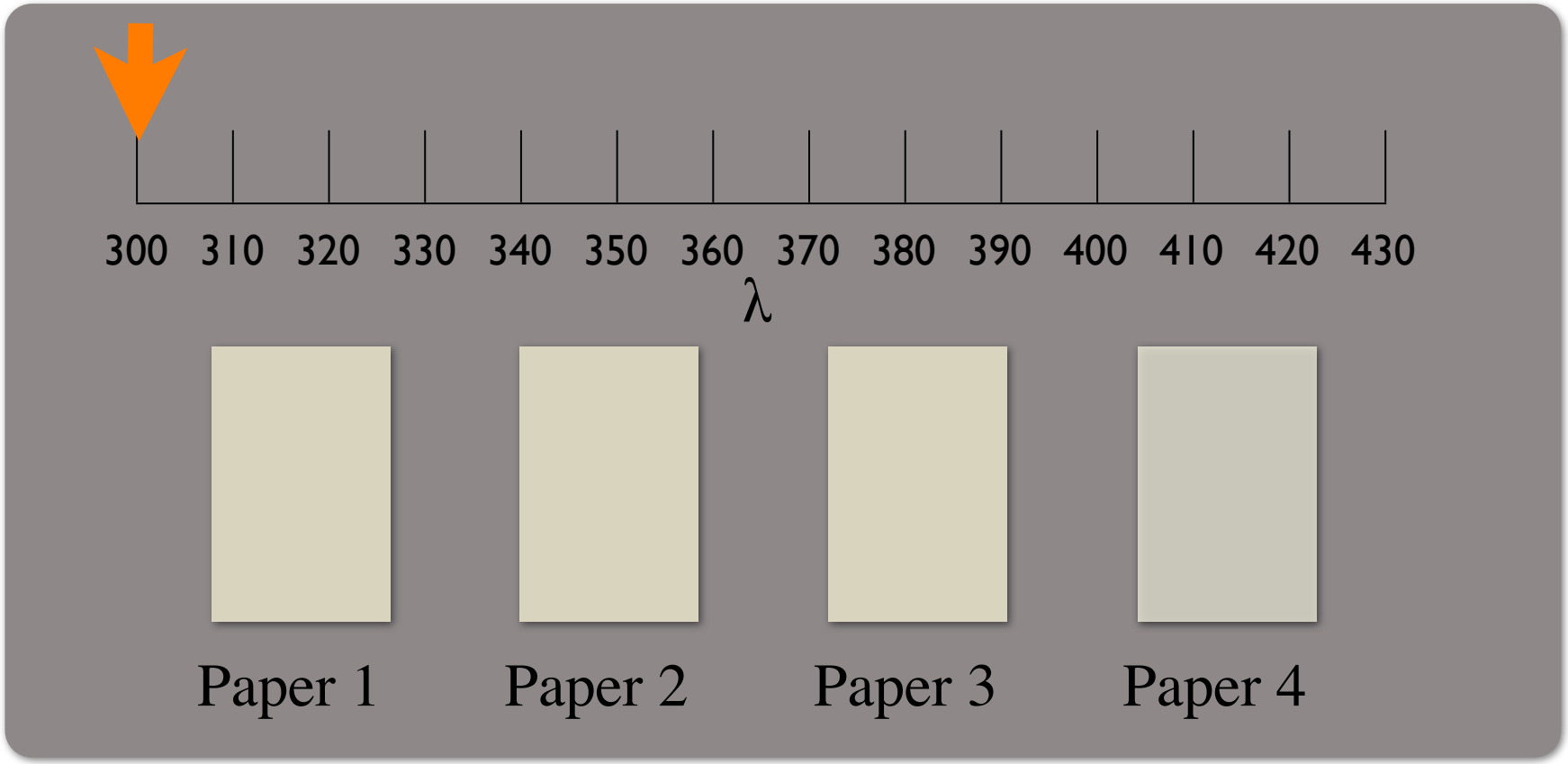
- Fluorescence is an additive component and can be considered as a "light source"

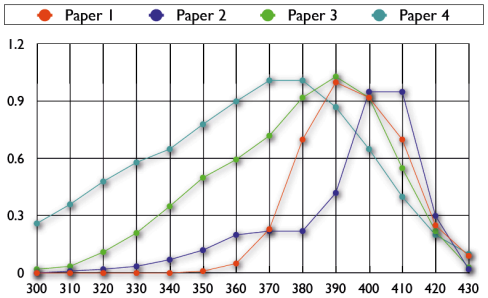
- Typical model



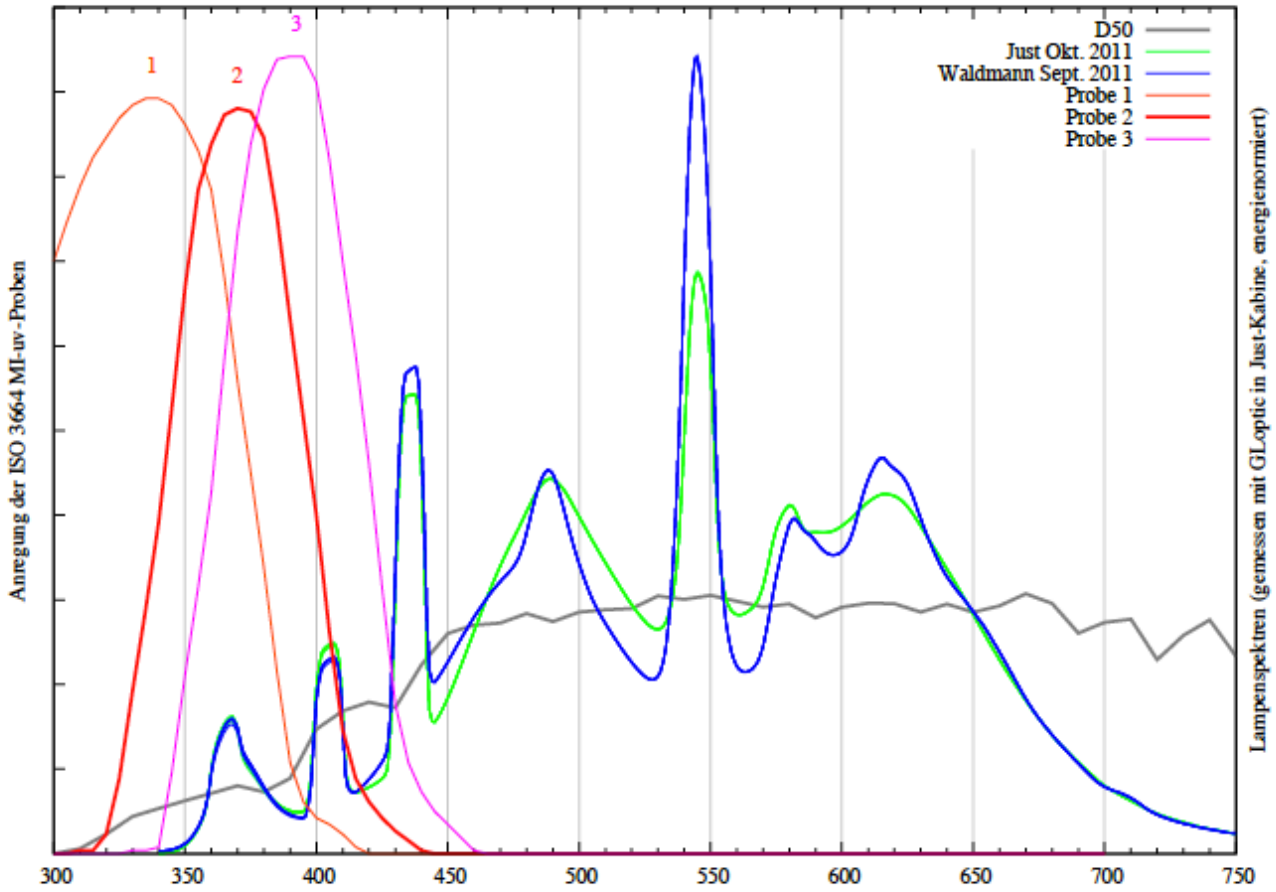
Source: 2006, Ehbets (X-RITE)

2. OBA absorb differently





2. OBA absorb differently



Wellenlänge in nm

Different light sources normalized to same area

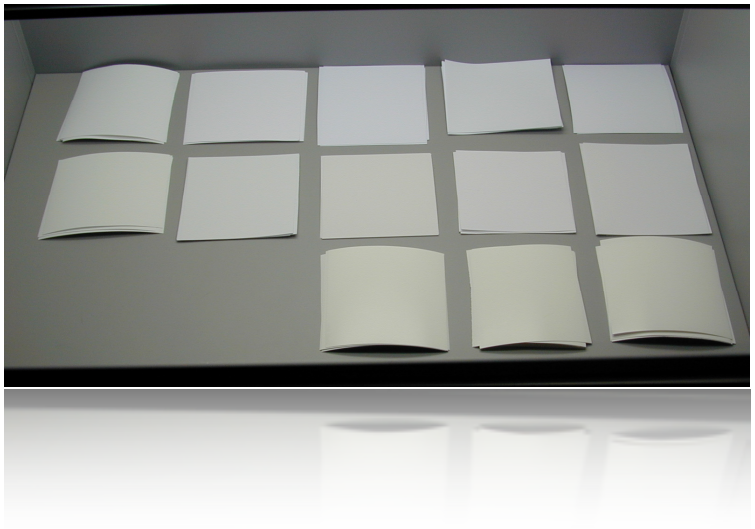
¬ "Luckily" the OBAs used in typical graphic arts paper are very similar (not yet checked for textiles used for digital printing)

¬ Assumption: Spectral absorption ⇒ α(λ) ⇒ CIE 51 "Type 2"

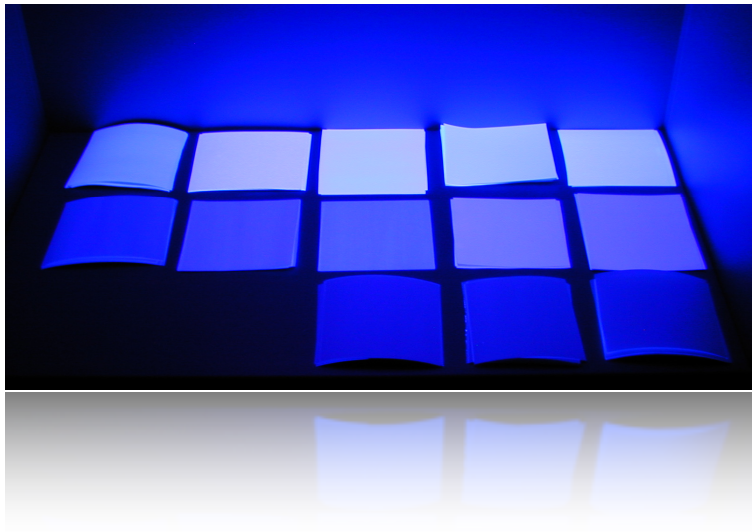
3 Governing factors: UV-amount / OBA-amount

- UV- and OBA-amount are governing factors
- Screening and Reflection/Absorption of the colorants within the UV-area are secondary aspects

Viewing Cabinet - D50



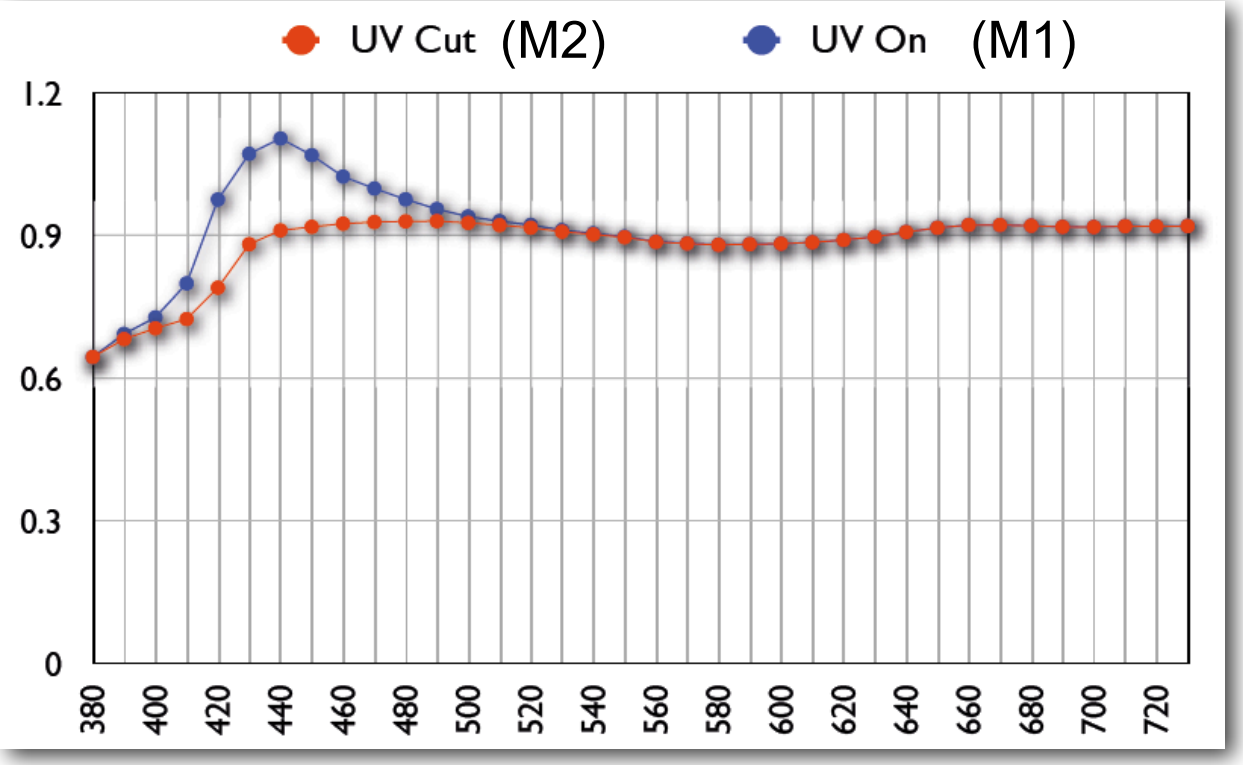
Viewing Cabinet - “UV-Only”



Substrates with different OBA amounts

3 Governing factors: OBA-Amount

- Different correlates are possible
- Established: Whiteness, Difference of CIEb*-values measured with M1/M2
- "ΔB", i.e. the difference of D65 Brightness (ISO 2470-2) and D65 Brightness without UV excitation as defined in ISO 15397



3 Governing Factors: UV-Amount

¬ Different correlates possible

¬ Direct Methods:

$$UV_{Anteil} = \frac{\sum_{\lambda=300nm}^{400} S(\lambda)}{\sum_{\lambda=401nm}^{730} S(\lambda)}$$

¬ Indirect Methods: Evaluate the effects based on typical papers/substrates

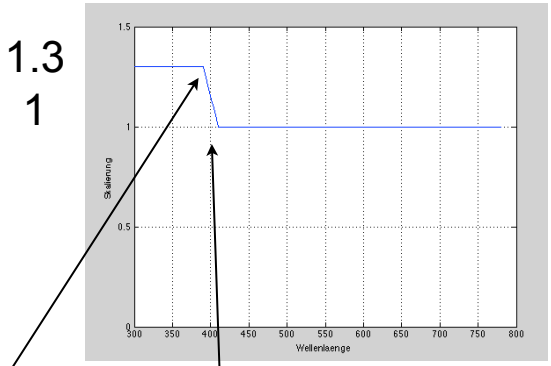
NEU

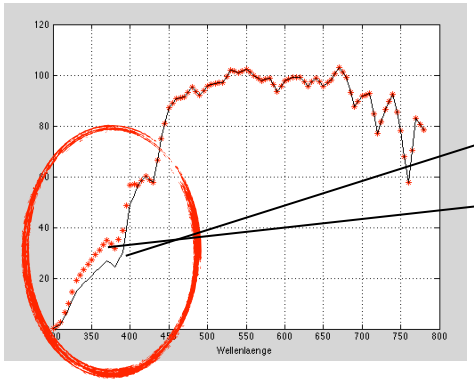
1. Define UV-amount (weighting)

2. Modify the spectra to be evaluated

3. Calculate Δb [MI_{UV}] for type 2 according to CIE 51

4. Calculate the correspondent UV amount



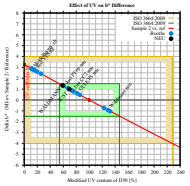


1	93.1735	0.4189	1.1935
2	93.2256	0.5420	0.3770
3	93.2935	0.0750	0.7327

1	93.1236	0.2337	2.0291
2	93.1711	0.3323	1.3330
3	93.2477	-0.1172	1.6146

Δb = 0,95

Regression based on UV-Variation according to ISO 3664



3. Calculation I: UV-amount$_{GD}$ (new method)

- Focus on the effect, hence the excitation of typical papers
- Restrict usage on D50 (metamers)
- Variation of UV-amount within tolerances of 3664:2000

⇒ UV-amount$_{GD}$ = 0% ⇒ Δb=4

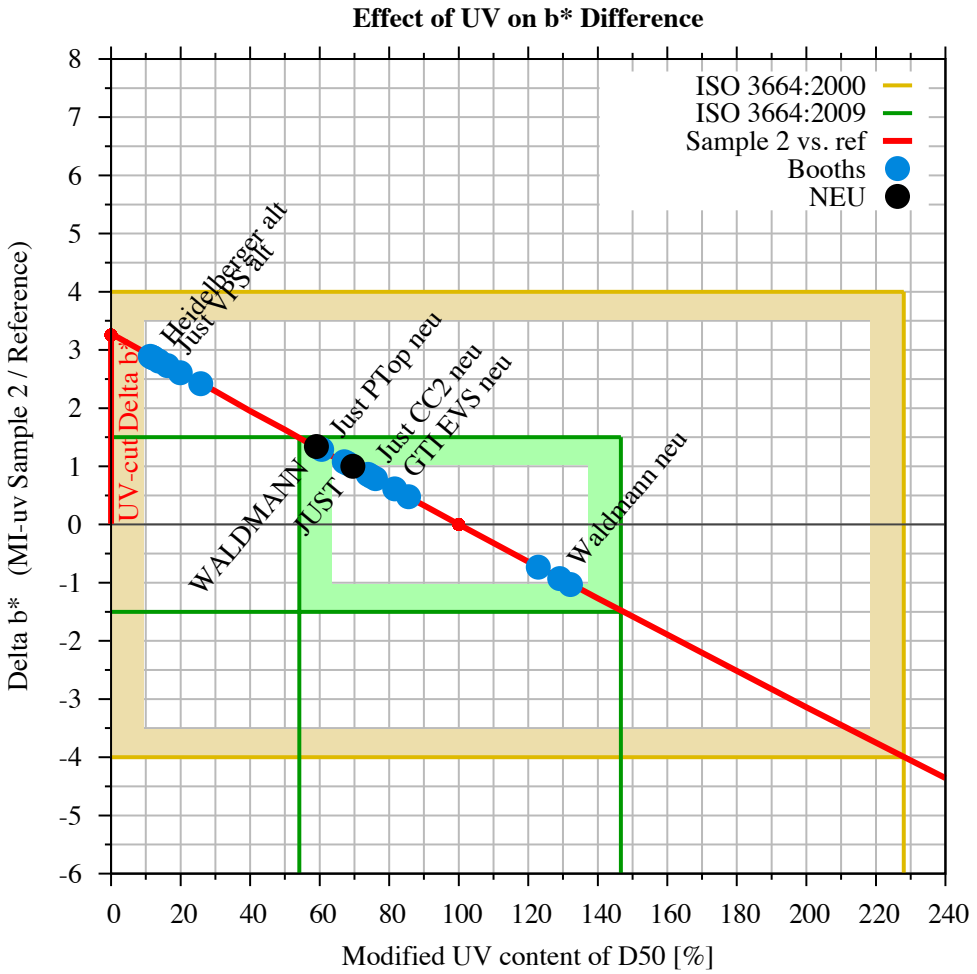
⇒ UV-amount$_{GD}$ = 230% ⇒ Δb=-4

- Variation of UV-amount within tolerances of 3664:2009

⇒ UV-amount$_{GD}$ = 53% ⇒ Δb= 1,5

⇒ UV-amount$_{GD}$ = 148% ⇒ Δb= -1,5

- Visualising typical viewing cabinets and measurement devices



Source: Hoffstadt, 2012

3. Calculation II: UV-amount$_{GD}$ (new Method)

Regression:

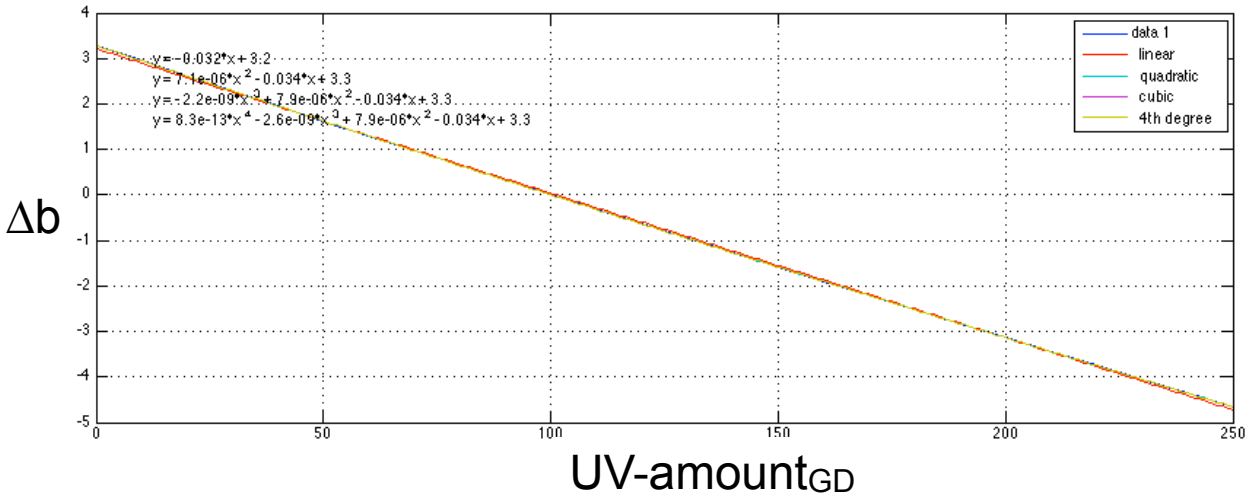
- quadratic fit is quite accurate by using:
  a=7E-06
  b=-3E-02

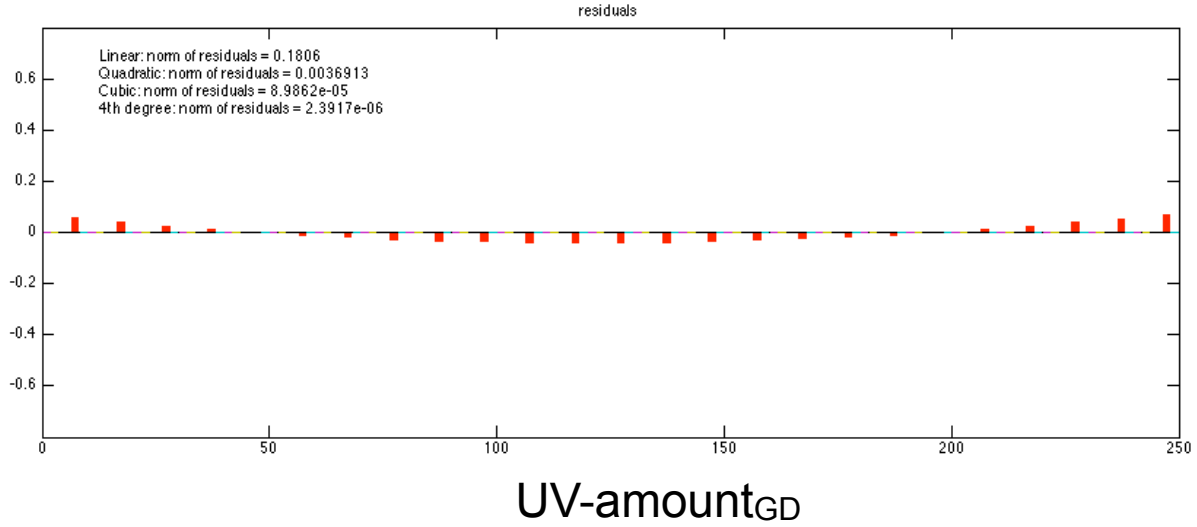
- Solving for:

$$UV - Anteil = \frac{-b - \sqrt{b^2 + 4a \cdot \Delta b}}{2a} + 100$$

- UV-amount$_{GD}$ @ Δb=0,95

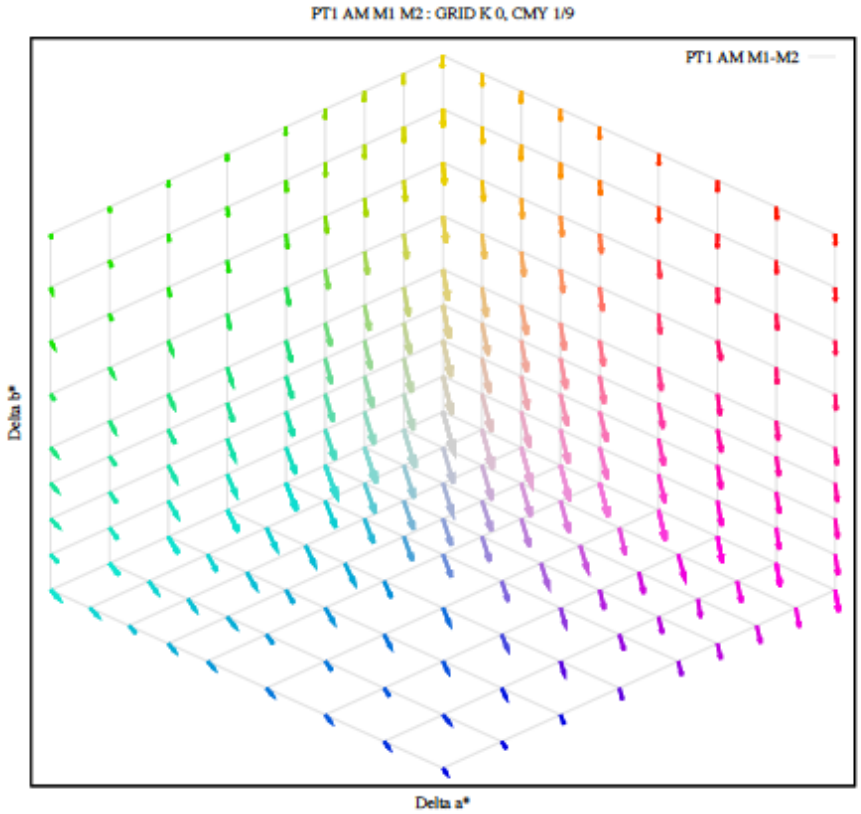
- UV-amount$_{GD}$=70,6%




residuals
Linear: norm of residuals = 0.1806
Quadratic: norm of residuals = 0.0036913
Cubic: norm of residuals = 8.9862e-05
4th degree: norm of residuals = 2.3917e-06
UV-amount$_{GD}$

4 Evaluating OBA-Characteristic

- Modelling is complex and for practical usage (yet) not precise enough
- Practical solution by capturing two measurements
  - ECI2002 test chart without UV-excitation (UV-Cut ⇒ ISO 13655:2009 M2)
  - ECI2002 test chart with D50 UV-excitation (ISO 13655:2009 M1)
- Creating a vector filed that allows to evaluate the "OBA effect"



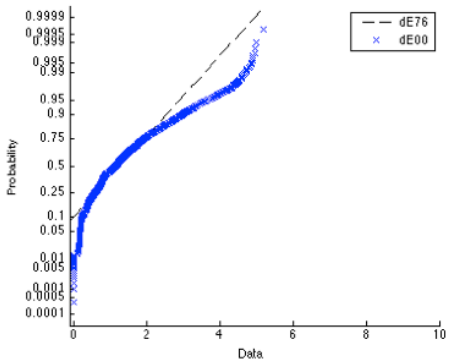
Source: Hoffstadt, 2012

4 OBA-Characteristic - error distribution?

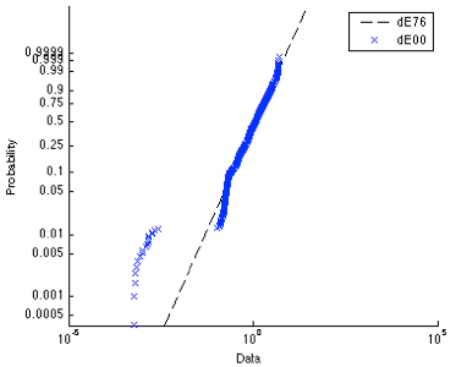
¬ The error distribution does not follow a typical distribution
⇒ use an empirical description

¬ Fehlerverteilung eines M1/M2 Vektorfelds (Offsetdruck, 60 er Raster)

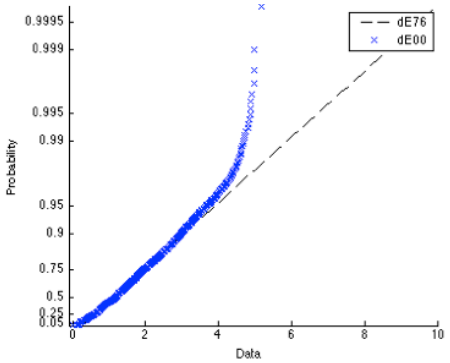
normal distrubtion



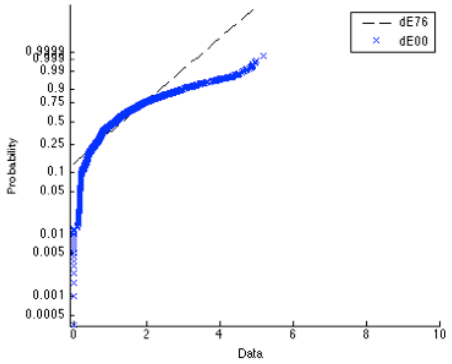
Weibull



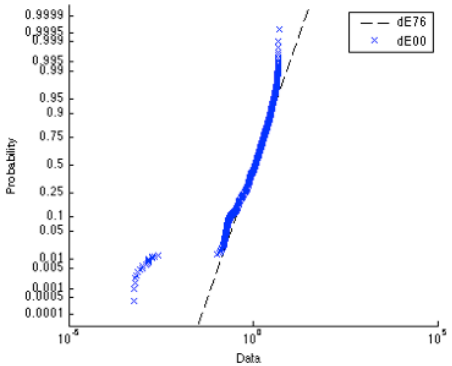
Exponential



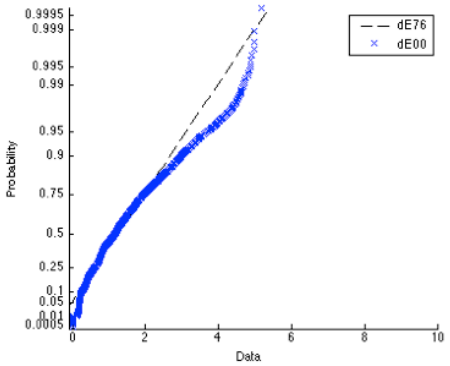
Extreme value



Lognormal



Rayleigh

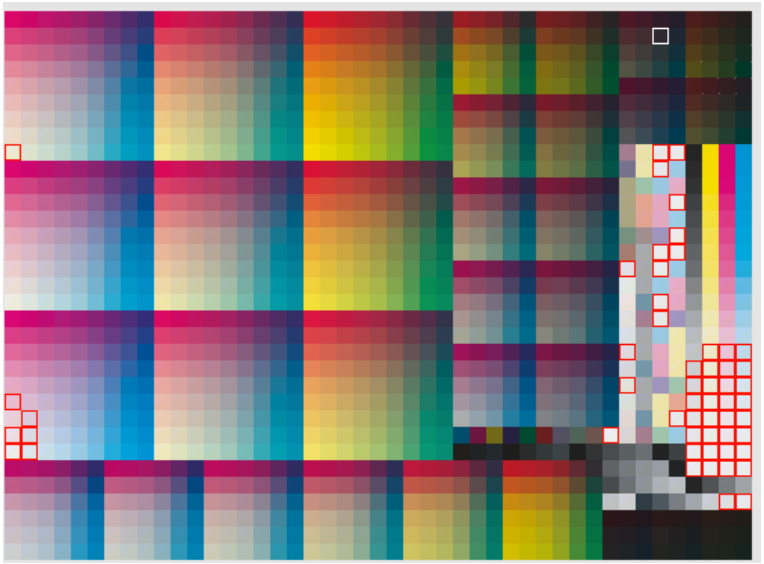


PS: perfect fit would be the dashed line

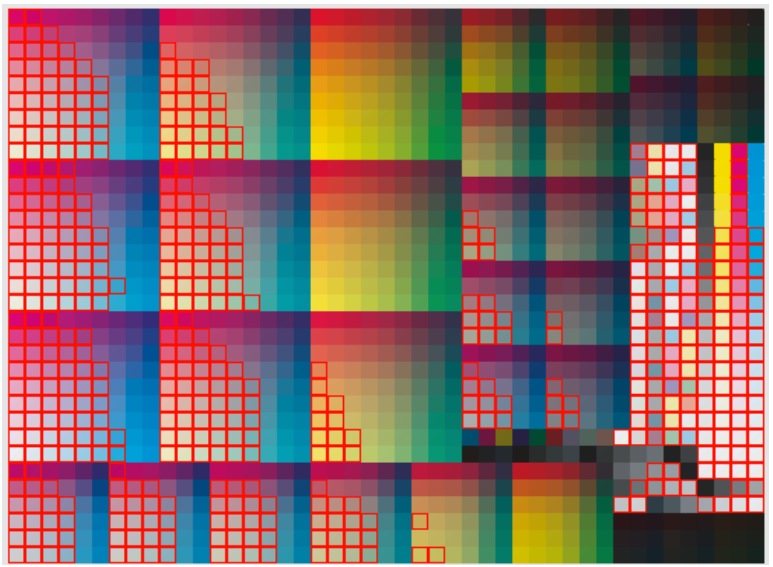
4 OBA-Characteristic - error distrubtion

- The largest differences are on the substrate (Paper)
- Yellow is affected at least since it absorbs the UV light (hence no/less UV can excite the OBA "sitting" in the substrate)

$\Delta E^*_{ab} > 5$



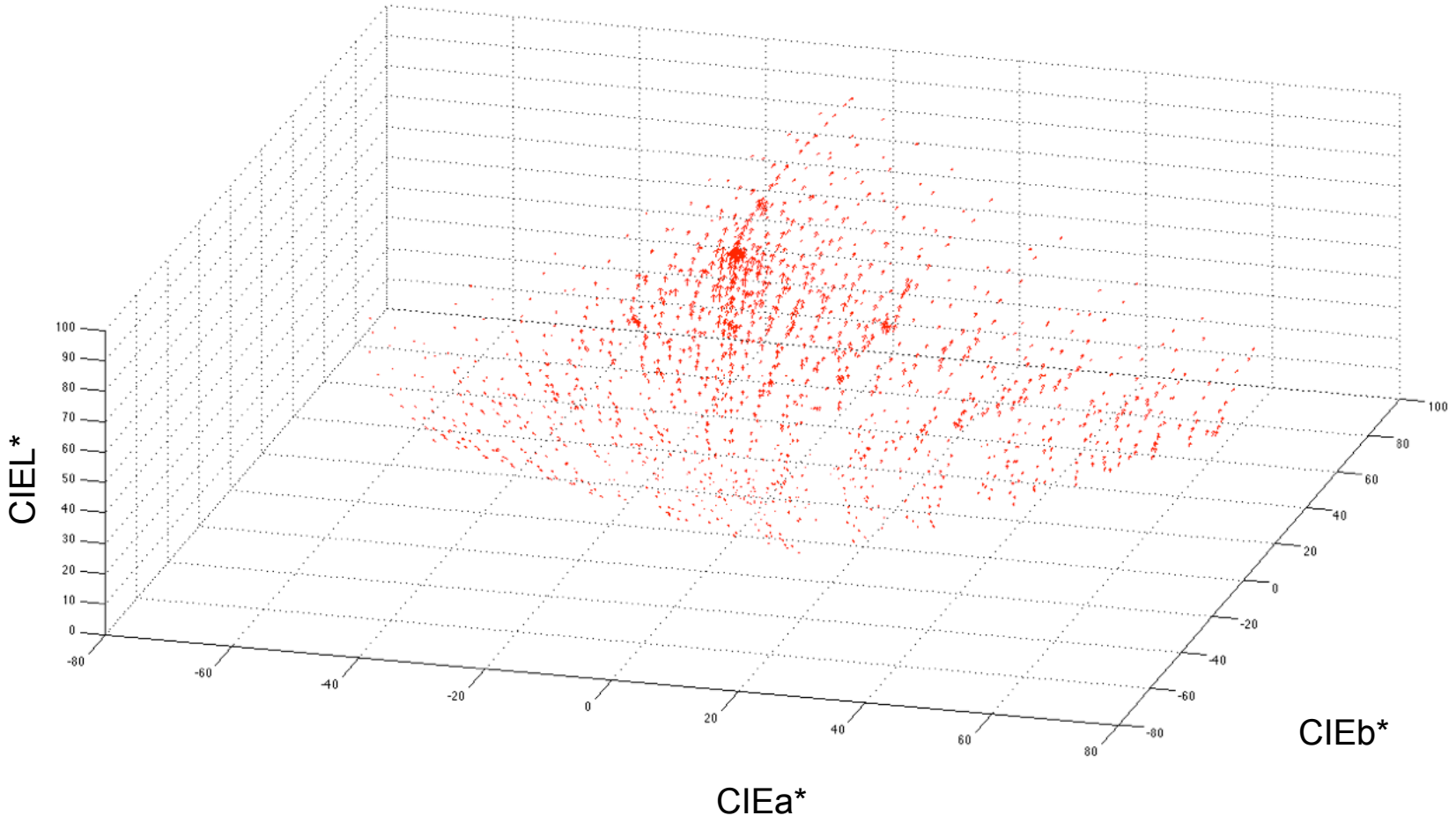
$\Delta E^*_{ab} > 2$



Example: Offset print, coated stock, screening: 60/cm

4 OBA-Characteristic - 1st impression

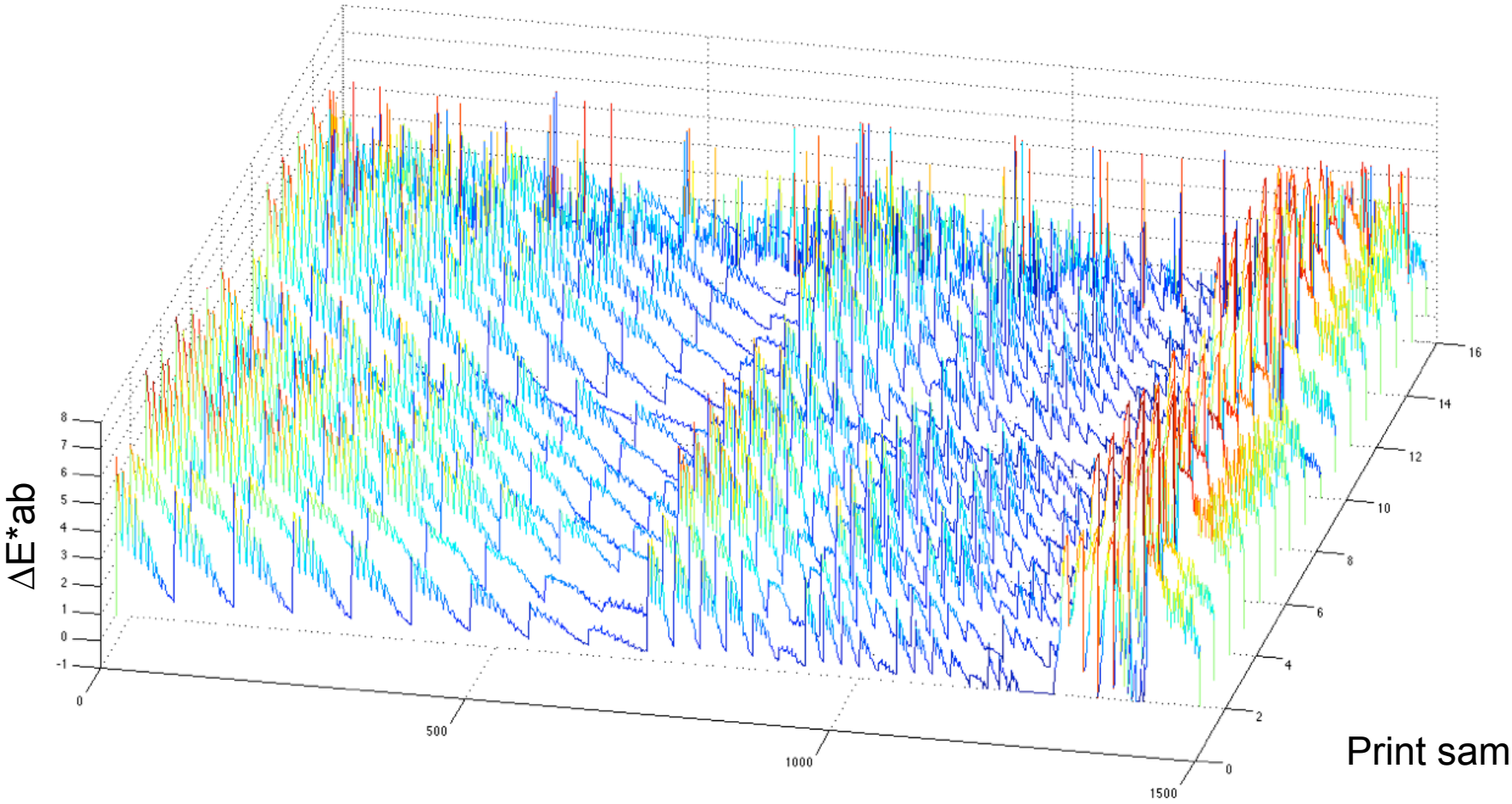
- Visualising colour differences (M1-M2) by means of a vector field
- here: 2x enlarged



Finesse Matt, coated paper, screening: 60/cm

4 OBA-Characteristic

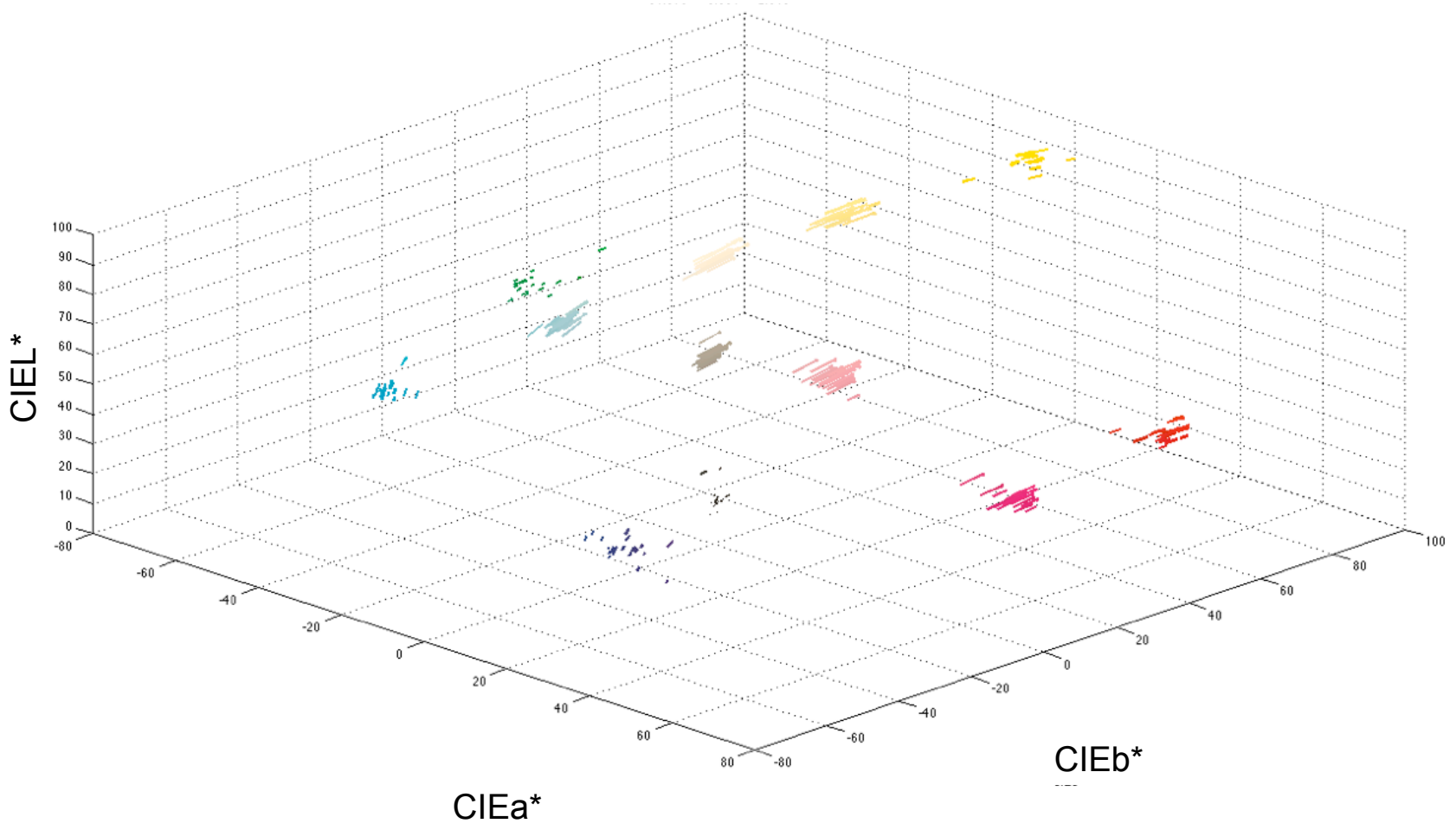
- Coated papers ⇒ Overview
- Similar behaviour ⇒ Grouping possible [Substrate, Screening, Colorant]



ECI 2002 test patches

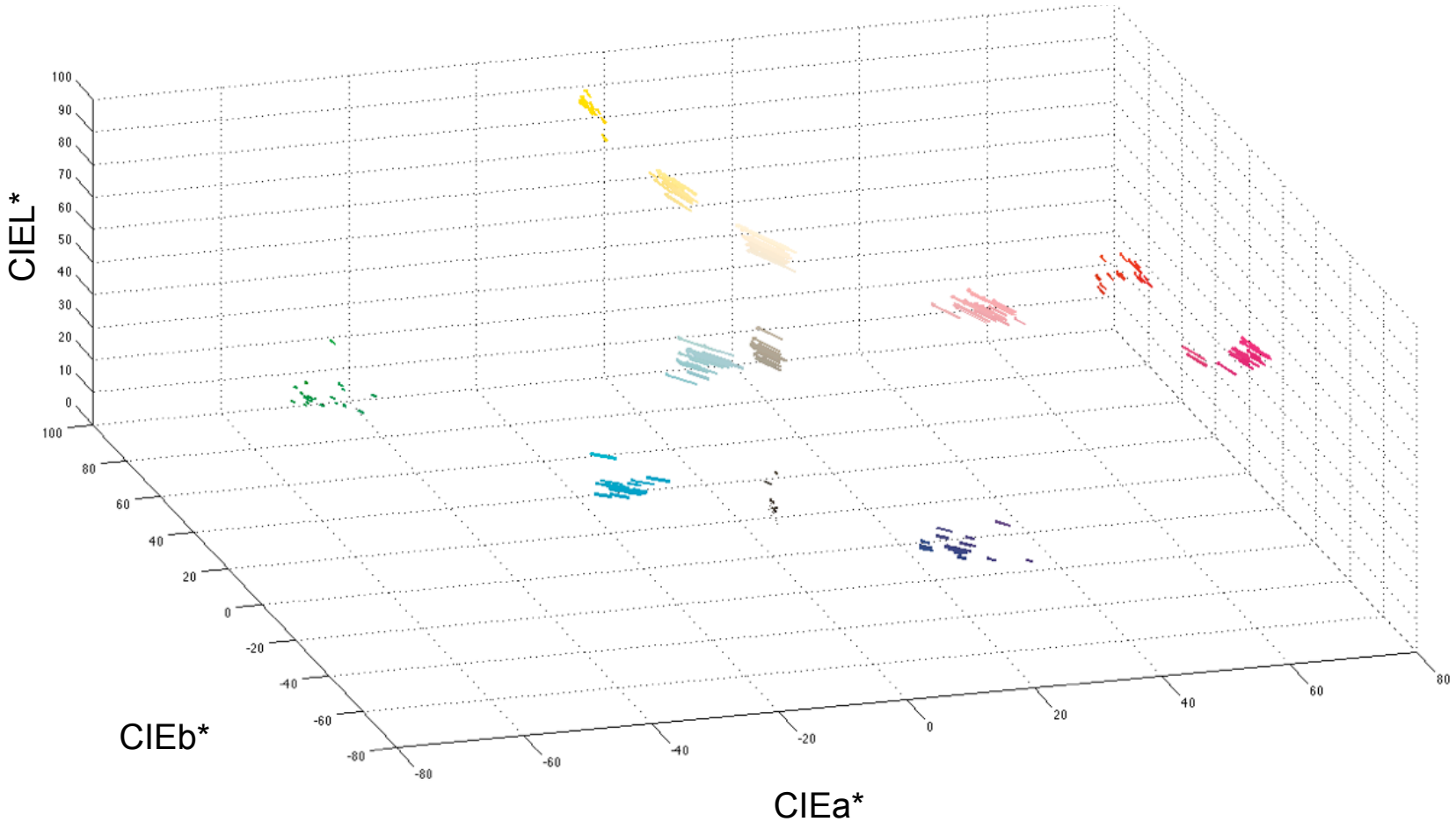
4 OBA-Characteristic - Details

- Coated Papers ⇒ CMYKRGB, Midtones and paper
- Similar behaviour ⇒ Grouping possible [Substrate, Screening, Colorant]



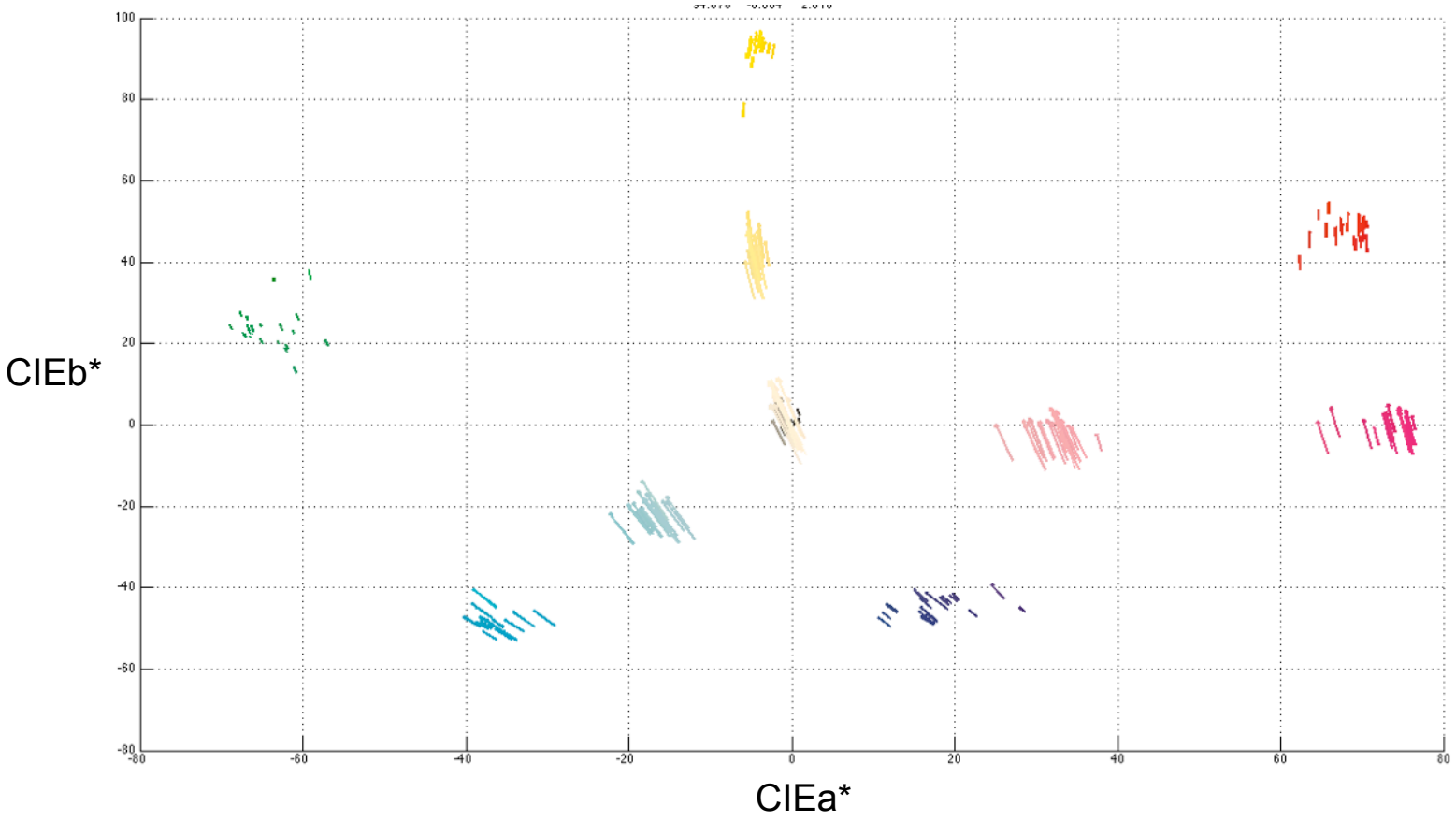
4 OBA-Characteristic - Details

- Coated Papers ⇒ CMYKRGB, Midtones and paper
- Different perspective



4 OBA-Characteristic - Details

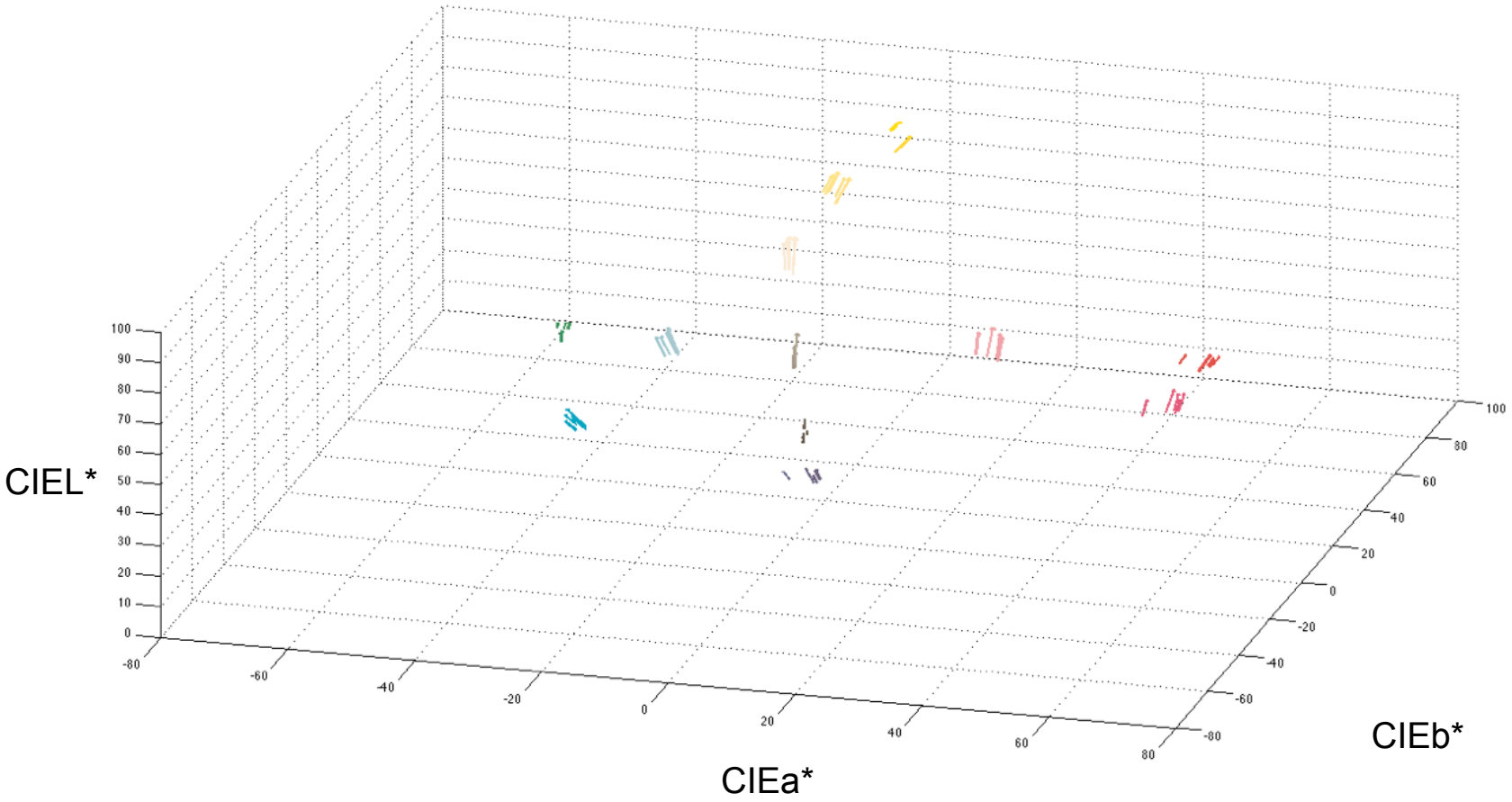
- Coated papers ⇒ CMYKRGB, Midtones and paper
- Projection into CIEa*b*-plane



4 OBA-Characteristic - Details

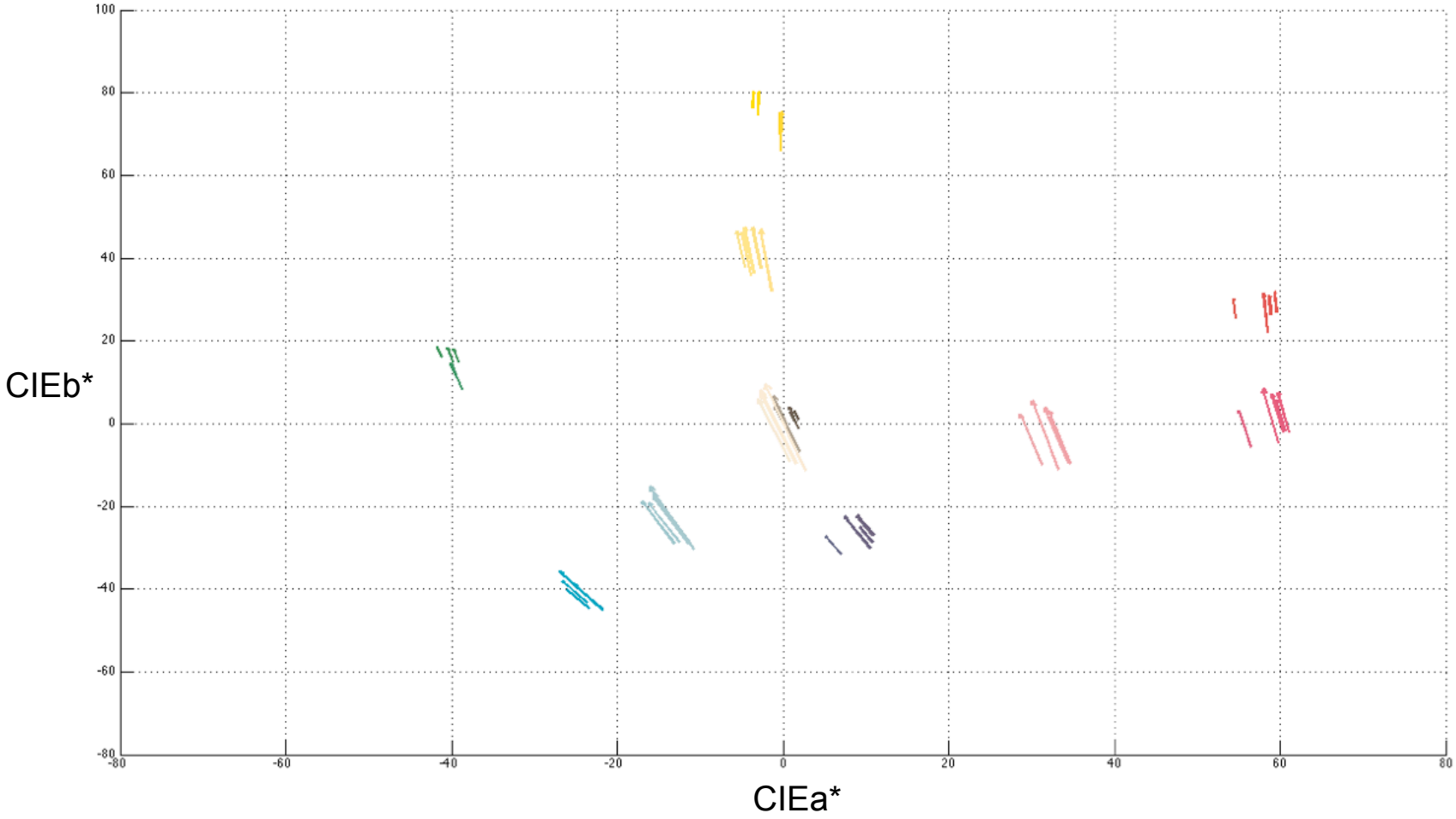
¬ Uncoated Papers ⇒ CMYKRGB, Midtones and paper

¬ Similar behaviour ⇒ Grouping possible [Substrate, Screening, Colorant]

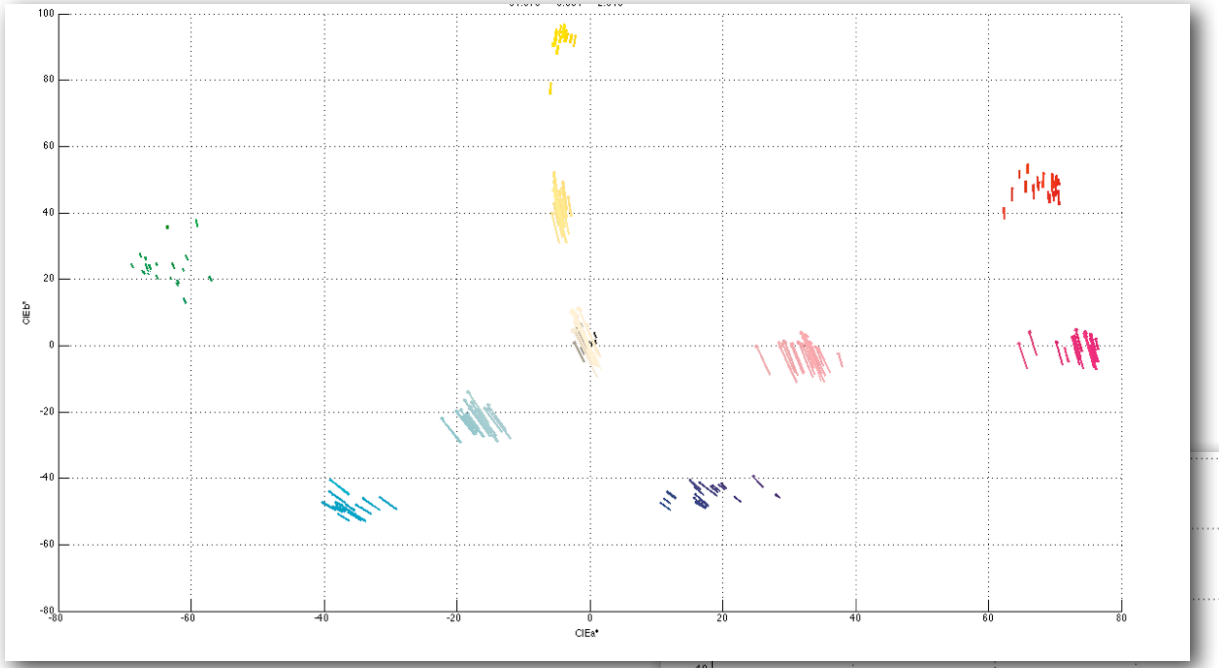


4 OBA-Characteristic - Details

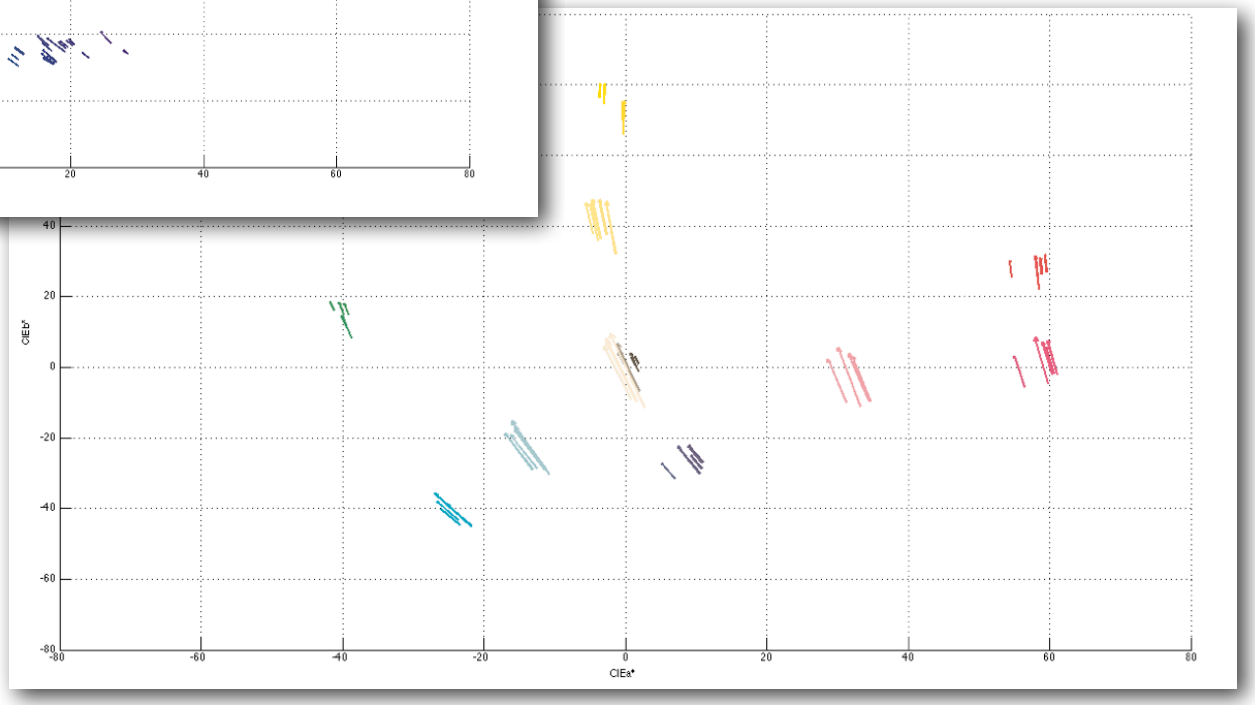
- Uncoated Papers ⇒ CMYKRGB, midtones and paper
- Projection into CIEa*b*-plane; similar behaviour but larger differences



4 OBA-Characteristic - Comparison



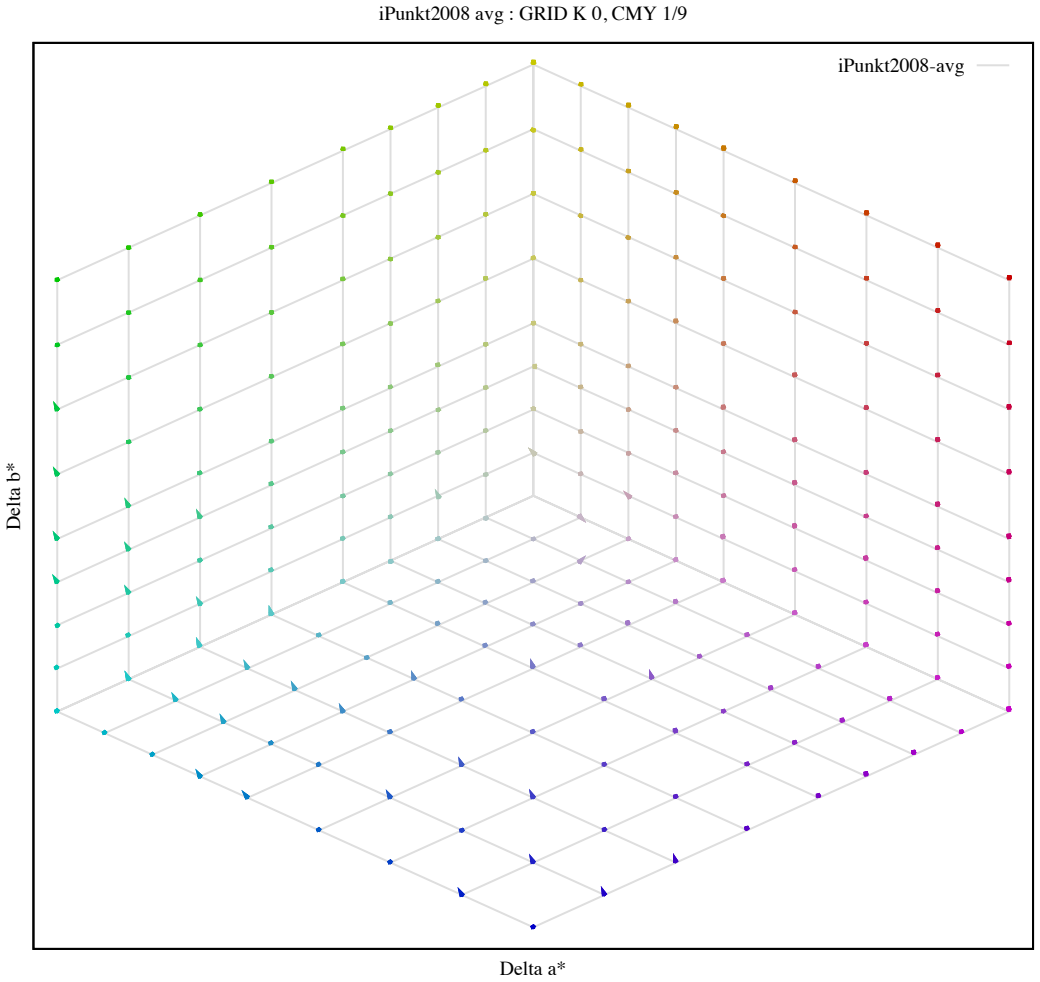
coated papers



uncoated papers

4 OBA-Characteristic - Individual deviation

Deviation of one selected paper (BVS glossy) with the established average (from the coated papers)



ALl ΔLab are scaled by the factor -6 / Δb ⇒ then averaged

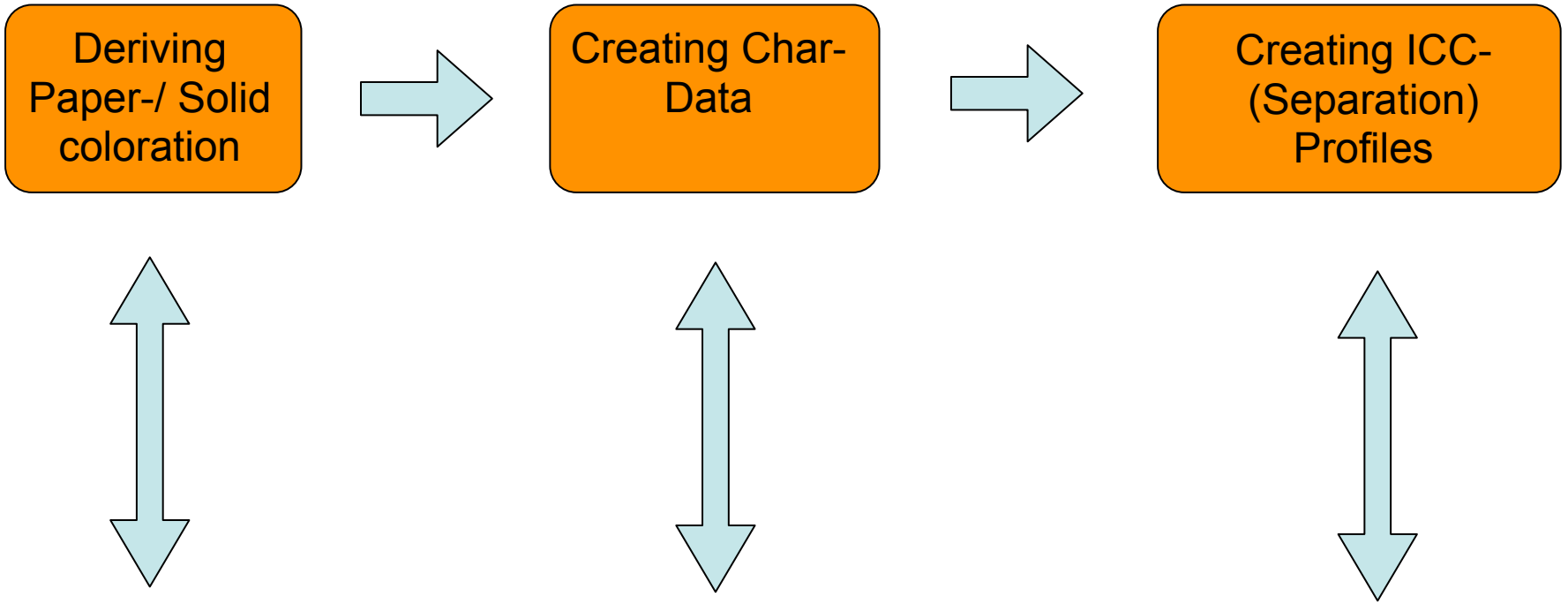
4 OBA-Characteristic - Intermediate findings

- **Qualitative** differences are as follows:
  - Graphic arts papers share a similar OBA agent ("Type 2")
  - Coated papers have a smaller effect than uncoated
  - The differences are mostly toward the chromaticness and less the lightness
  - The largest differences can be found in the substrate (as expected)
  - Magenta and Cyan solids react strongly
  - Yellow and Green (Cyan and Yellow) solids react weakly
  - Screening has a hue dependent impact
  - Further studies and evaluations (e.g. softproof) will follow

- **Quantitative** differences are as follows:
  - Coated papers have a typical paperwhite difference (M1-M2) of Δb=3-6
  - UnCoated papers have a typical paperwhite difference (M1-M2) of Δb=3-10
  - Further studies will follow

5. Char.-Data and ICC-Profiles

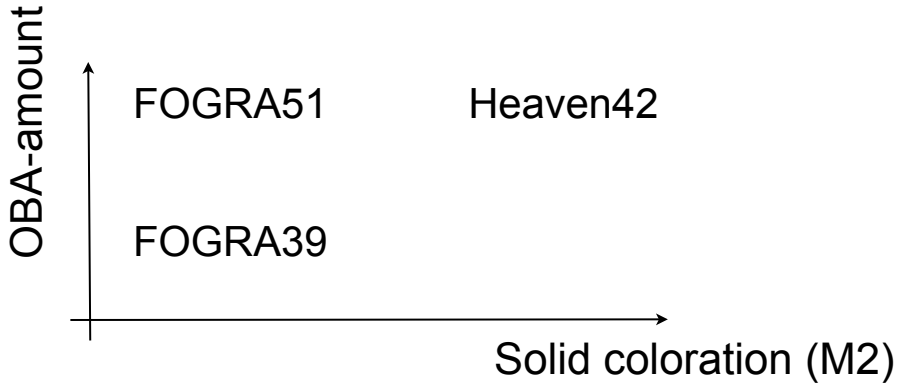
- Current characterization data (e.g: FOGRA39) bases on measurements with light sources similar to illuminate A (illuminant A ⇒ UV-amount$_{GD}$ ≈ 60%)
- New Char.-Data are required, which reflect the new measurement condition (M1)



Test for consistency - Print - Prepress

5. Char.-Daten and ICC-Profiles

- Creating new characterization data
- Ongoing datasets for coated and uncoated stock
- Basic procedure:
  1. Establishing a typical inking (excited by a defined UV-amount)
  2. Consider substrate correction by means of XYZ scaling
  3. Applying the representative vector field
- Coated Papers ⇒ FOGRA51
- Uncoated Papers ⇒ FOGRA52
- Aim:



6. Summary & Outlook

- Colour management works ⇒ when you measure as you see the visual agreement is very good
- New method developed for calculating the UV amount based on the resulting effect (however the UV amount is an additional variable that needs to be communicated")
- M1/M2-Vector fields allow for qualitative and quantitative evaluation of the OBA-effect together with the governing (contribution) factors
- Char.-data needs to be tested carefully including the ongoing revision of ISO 12647-2/3
- Further evaluations are needed (in particular with respect to colour adaptation)